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PATENT & TRADEMARK OFFICE

#AF 2811

Docket No.: GR 97 P 2734

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By: Markus Nolff Date: June 6, 2001

#19
appeal
Brief
F Jones
6-20-01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Before the Board of Patent Appeals and Interferences

Applicant : Frank Hintermaier

Applic. No.: 09/161,196

Filed : September 25, 1998

Title : Capacitor Having a Barrier Layer Made of a Transition Metal Phosphide, Arsenide or Sulfide

Examiner : Cuong Q. Nguyen - Art Unit: 2811

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BRIEF ON APPEAL

Hon. Commissioner of Patents and Trademarks,
Washington, D. C. 20231,

Sir:

This is an appeal from the final rejection in the Office action dated March 2, 2001, finally rejecting claims 1, 3, 5 and 7-12.

Appellants submit this Brief on Appeal in triplicate, accompanied by a check for $310.00 to cover the fee for filing the Brief.

06/12/2001 HVUONG1 00000073 09161196
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Real Party in Interest:

This application is assigned to Siemens Aktiengesellschaft of München, Germany. The assignment will be submitted for recordation upon the termination of this appeal.

Related Appeals and Interferences:

No related appeals or interference proceedings are currently pending which would directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

Status of Claims:

Claims 1, 3, 5 and 7-12 are rejected and are under appeal. Claims 2, 4, 6 and 13-24 are withdrawn from further consideration.

Status of Amendments:

No claims were amended after final. A response after final (37 CFR § 1.116) was filed on February 9, 2001. The response filled after final did not contain a proposed amendment either to the claims or to the specification.

Summary of the Invention:

As stated in the first paragraph on page 1 of the specification of the instant application, the invention

relates to a capacitor in an integrated circuit, in particular in an integrated semiconductor memory.

Appellant explained on page 11 of the specification, line 14, that, referring to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is seen a capacitor that is used as a storage capacitor in an integrated semiconductor memory, in particular a DRAM or FRAM. The figure shows a silicon substrate 1 having, arranged on it, a MOS transistor which comprises two doped regions 3, 4 and a gate 5 that is insulated relative to the substrate. Inactive regions of the circuit are covered with an insulation 2. An insulation layer 6 covers the transistor. A structure 7 connects to the doped region 3. The other doped region 4 is connected via a further connection structure 8 to a bit line 9. In this case, the connection structure 7 consists of tungsten, with which a contact hole etched into the insulation layer 6 is filled. The insulation layer 6 may consist of silicon oxide or nitride. In order to produce the barrier layer, the existing structure is then heat-treated in a PH_3 atmosphere. The tungsten W then reacts with the PH_3, so that WP 10 is formed self-aligned on the connection structure 7. Typical parameters of the heat treatment are a temperature of from 800 to 1100°C and a pressure of from 0.1 to 10 torr PH_3. Part of the connection

structure 7 is thus converted directly into WP. The layer thickness of the barrier 10 can be adjusted through the duration of the heat treatment. A typical value for the thickness of the layer 10 is about 30 nm.

Appellant stated on page 12 of the specification, line 13, that, referring to Fig. 2, the lower electrode 11 of the capacitor is then applied, for example by sputtering an approximately 30 nm thick Pt layer and suitable structuring. After this, a high- dielectric 12 is deposited. During the deposition, the tungsten phosphide acts as a barrier preventing oxygen from diffusing in, and prevents oxidation of the connection structure 7. Lastly, a second electrode 13 of the capacitor is produced, for example from platinum. In the exemplary embodiment, the electrode 13 represents the so-called common plate for all the capacitors.

Appellant further outlined on page 12 of the specification, line 24, that, referring to Fig 3, the second embodiment commences with the same prefabricated basic structure as the first exemplary embodiment, that is to say a substrate having a MOS transistor which is covered with an insulation layer 6, a connection structure 7 being connected, passing through this insulation layer 6, to a doped region 3 of the transistor. The barrier layer 10 is then applied surface-

wide to this structure by CVD. To that end, a mixture of tungsten chloride (WCl_6), hydrogen (H_2) and phosphine (PH_3) is produced in a chamber. At a temperature of from 400 to 800°C and a pressure of from 0.1 to 10 torr, tungsten phosphide (WP) is deposited on the entire surface. As an alternative, tantalum phosphide may also be deposited from the starting materials $TaCl_5$, H_2 and PH_3 in a CVD process. Platinum is applied on top as the material of the lower electrode 11.

Appellant explained on page 13 of the specification, line 14, that, referring to Fig. 4, the two layers 10, 11 are structured with the aid of a photographic technique in an etching process, so as to form a first electrode 11 which then lies on the barrier layer 10. As in the first illustrative embodiment, the capacitor is fabricated by production of the capacitor dielectric 12 and of the second electrode 13.

Appellant further outlined on page 13 of the specification, line 21, that the barrier layer 10 may also be arranged on the first electrode 11. Since, in this case, it also needs to cover the sides of the first electrode, the first electrode is expediently structured initially, and then the barrier layer is applied. The first electrode and the barrier layer may, however, also be structured together,

wherein case the sides of the first electrode need to be covered, for example, by a spacer made of the material of the barrier.

References Cited:

U.S. Patent No. 5,566,045 (*Summerfelt et al.*), dated October 15, 1996;

U.S. Patent No. 5,691,219 (*Kawakubo et al.*), dated November 25, 1997;

Issues

Whether or not claim 1 is anticipated by *Summerfelt et al.* or *Kawakubo et al.* under 35 U.S.C. §102.

Grouping of Claims:

Claim 1 is independent. Claims 3, 5 and 7-12 depend on claim 1. The patentability of claims 3, 5 and 7-12 is not separately argued. Therefore, claims 3, 5 and 7-12 stand or fall with claim 1.

Arguments:

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for, inter alia:

> a ***barrier layer*** disposed below said capacitor dielectric, said barrier layer consisting essentially of a compound formed from a ***transition*** element and a material selected from the group consisting of phosphorus, sulfur, and arsenic.

Regarding the anticipation rejection over *Summerfelt et al.* The Examiner states on page 2 of the final Office action dated November 6, 2000, that "Summerfelt et al. disclose … a GaP layer … which is a compound of a ***transition*** element (Ga)" (emphasis added). It is respectfully pointed out that gallium is a group IIIb element and, therefore, is not a transition element. Enclosed is a copy of the periodic table and a definition of "transition element" from the ENCYCLOPAEDIA BRITANNICA. Hence, claim 1 is believed not to be anticipated by *Summerfelt et al.*.

Regarding the anticipation rejection over *Summerfelt et al.*

The Examiner states on page 3 of the Office action of the final Office action dated November 6, 2000, that "Kawakubo et al. does not explicitly teach that the barrier is a compound of a transitional element and phosphorous. It is inherent that the transitional metal layer (12) will react with phosphorous from the connection structure to form a barrier material such as a TiP or TiP [sic]. Therefore, it is inherent that Kawakubo et al.'s device including a barrier of TaP or TiP. See reference US 6015997 col. 7 lines 55-60 which was cited to support the inherence".

According to the conclusions reached by James Forbes, *Inherency in U.S. Patent Law*, III NEWS SOURCE No. 1, page 18 (Winter 2001), (a copy of the article is enclosed):

> 6. An element of a claim that is not expressly disclosed in a prior art reference is inherently disclosed therein if, and only if, the "missing" element is *necessarily* present in prior art. *Hansgirg, supra*.

The author concludes stating "[f]or the practitioner, probably the most important lesson to be drawn is this: anticipation of a claim by a prior art reference under the principles of inherency requires that the inherency be ***absolute, and not probabilistic***. The CAFC's holding of validity in *Glaxo II, supra*, is perhaps the clearest demonstration of this lesson" (emphasis added).

U.S. Patent No. 6,015,997, states at col. 7, lines 55-60, that "[c]ertain Group VB nonmetal elements, such as: N, P, As, and Sb, ***can*** react with titanium to form barrier materials" (emphasis added). The word "can" is probabilistic and, hence, not absolute or certain. Therefore, according to the conclusion reached by James Forbes, *Inherency in U.S. Patent Law*, U.S. Patent No. 6,015,997, does not offer support for Examiner's statement that "[i]t is inherent that the transitional metal layer (12) will react with phosphorous from the connection structure." To the contrary, U.S. Patent No. 6,015,997, offer support that it is ***not*** inherent that the transitional metal layer will react with phosphorous from the connection structure, as alleged by the Examiner.

Even if for arguments shake, it is assumed that it is inherent that the transitional metal layer will react with phosphorous from the connection structure, it is not necessarily inherent, that the formed component will result in a barrier ***layer***, as recited in claim 1. Therefore, according to the conclusion reached by James Forbes, *Inherency in U.S. Patent Law*, there is no support for the Examiner's statement that "it is inherent that Kawakubo et al.'s device including a ***barrier*** of TaP or TiP." (emphasis added).

Hence, it is believed that it is not inherent that the transitional metal layer will (i) ***necessarily react*** with phosphorous from the connection structure to form (ii) a barrier ***layer***. Therefore, claim 1 is not believed to be anticipated by *Kawakubo et al.*

Consequently. it is believed that neither *Summerfelt et al.* nor *Kawakubo et al.* show a barrier layer formed from a ***transition*** element and a material selected from the group consisting of phosphorus, sulfur, and arsenic as recited in claim 1 of the instant application.

The honorable Board is therefore respectfully urged to reverse the final rejection of the Primary Examiner.

Respectfully submitted,

Markus Nolff

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For Appellant

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Appendix - Appealed Claims:

1. A capacitor in an integrated semiconductor circuit, comprising:

a semiconductor substrate having a doped region formed therein;

a first electrode connected to said doped region;

a second electrode;

a capacitor dielectric insulating said first electrode from said second electrode; and

a barrier layer disposed below said capacitor dielectric, said barrier layer consisting essentially of a compound formed from a transition element and a material selected from the group consisting of phosphorus, sulfur, and arsenic.

3. The capacitor according to claim 1, which further comprises a connection structure connecting said first electrode to said doped region.

5. The capacitor according to claim 3, wherein said barrier layer is disposed underneath said first electrode and covers an entire interface between said first electrode and said connection structure.

7. The capacitor according to claim 1, wherein said capacitor dielectric consists of a material selected from the group consisting of dielectric material and ferroelectric material, and has a value of $\varepsilon > 100$.

8. The capacitor according to claim 1, wherein said capacitor dielectric consists of a material selected from the group consisting of BST, SBT, PZT, and PLT.

9. The capacitor according to claim 1, wherein said first electrode consists of a material selected from the group consisting of Pt-containing material, Ru-containing material, Rh-containing material, and Ir-containing material.

10. The capacitor according to claim 3, wherein said connection structure is made of a material selected from the group consisting of polysilicon and tungsten.

11. The capacitor according to claim 1, wherein said barrier layer is essentially a layer selected from the group consisting of a tungsten phosphide layer, a tantalum phosphide layer, and a hafnium phosphide layer.

12. A semiconductor configuration, comprising a capacitor according to claim 1, and an associated selection transistor which encompasses said doped region.

alkali metals / alkaline earth metals / transition metals / other metals / other nonmetals / halogens / noble gases / lanthanides / actinides

period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Ia	IIa	IIIa** IIIb***	IVa IVb	Va Vb	VIa VIb	VIIa VIIb	VIIIa VIIIb	VIIIa VIIIb	VIIIa VIIIb	Ib	IIb	IIIb IIIa	IVb IVa	Vb Va	VIb VIa	VIIb VIIa	VIIIb 0
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 ****	105 ****	106 ****	107 ****	108 ****	109 ****	110 ****	111 ****	112 ****						

6	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
7	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

* Numbering system recommended by the International Union of Pure and Applied Chemistry (IUPAC)
** Previous IUPAC numbering system
*** Numbering system recommended by the Chemical Abstracts Service
**** For the names of elements 104–112, see Table 27.

Figure 1: Modern version of the periodic table of the elements. To see more information about an element, select one from the table.
Encyclopædia Britannica, Inc.